In addition to the wind tunnel test, calculations were made with a comprehensive rotorcraft analytical tool, CAMRAD II, to demonstrate current analytical capability. The second figure shows damping measurements of the regressing lag mode for the swept-tip rotor and CAMRAD II calculations. In the figure the damping coefficient, or exponent, is plotted versus the advance ratio (a measure of airspeed, μ = V/WR) for five collective pitch angles. The agreement between analysis and experiment is good for the lowest collective pitch angles; however, the analysis overpredicts damping as the collective pitch angle is increased. Further, the calculations do not capture the up-down-up character of the measurements with increasing advance ratio. An analytical study has been initiated to look at the sensitivity of damping to various physical model parameters and analytical model sophistication.

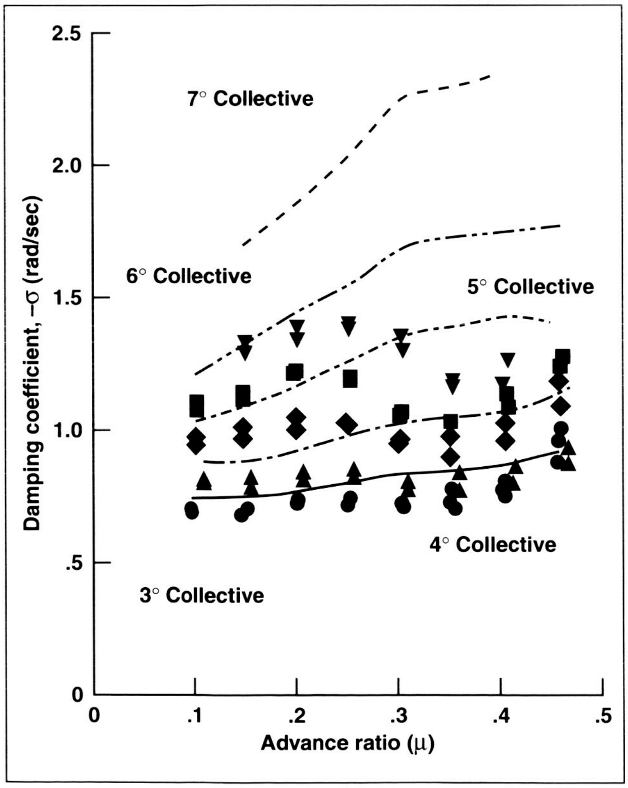

Fig. 2. A comparison of theory and experiment for the swept-tip rotor regressing lag mode stability in forward flight for various collective pitch angles.

Point of Contact: T. Maier
(650) 604-3643
tmaier@mail.arc.nasa.gov

Active Control of Stall on Helicopter Rotors

Khanh Q. Nguyen

In an effort to expand helicopter flight envelopes, this analytical study explores the potential of using higher harmonic blade pitch to reduce the adverse effects of dynamic stall on rotor blades. Since excessive stall-induced loads can damage rotor structural components, stall severely restricts helicopter maximum speed and loading capabilities. On the other hand, successful control of stall can enhance the utility of helicopters.

The rotorcraft analysis code UMARC (University of Maryland Advanced Rotorcraft Code) was modified for a stall suppression investigation of the UH-60A rotor. At a severe stalled condition, the analysis predicts three distinct stall events spreading over the retreating side of the rotor disk. Prescribed 2-per-rev input can reduce stall moderately, as shown in the figure, where the lift excess is used as a measure of stall; the other input harmonics are less effective. Stall responses to individual input harmonics exhibit highly nonlinear behaviors, rendering the closed-loop controller ineffective in suppressing stall and the combined effects of individual harmonics non-additive.

Point of Contact: K. Nguyen
(650) 604-5043
knguyen@mail.arc.nasa.gov